Elements of an AI/ML Architecture for NASA

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Outline

- About Agency Data Analytics Team
  - Our scope of work, sampling of projects
- The Problem : Enabling the best return on ML/AI technologies
  - Definition of ML, scope
  - Ingredients of ML/AI Data + Processing power
  - Understanding key aspects of ML in practice
  - Problems with doing ML @NASA
- Solutions / Elements
  - Data & Processing
- Summary

About Me

- ***What is an "Agency Data Scientist"?***

> ***"To Understand the Challenges and Capabilities of NASA in Data Science, Big Data and Data Analytics"***

  - Meet with folks around the agency
  - Meet with vendors
  - Targeted, pathfinding prototypes
  - Inform Data Strategy for Agency

Agency Data Analytics Team

- “Agency” + “Analytics/Data Science” + “Technology & Innovation”
- ***Core Activities:***

Text Analytics Machine Learning Statistical Modelling Data Visualization

Technology Evaluation Strategic Policy

Andrew Adrian
Senior Data Scientist

Anthony Buonomo
Data Scientist

Justin Gosses
Senior Data Scientist

Kyle Klarup
PMF/Data Scientist

Jackie Cho
Data Science Intern

Naylynn Tanon Reyes
Data Science Intern

- Website : https://analytics.nasa.gov

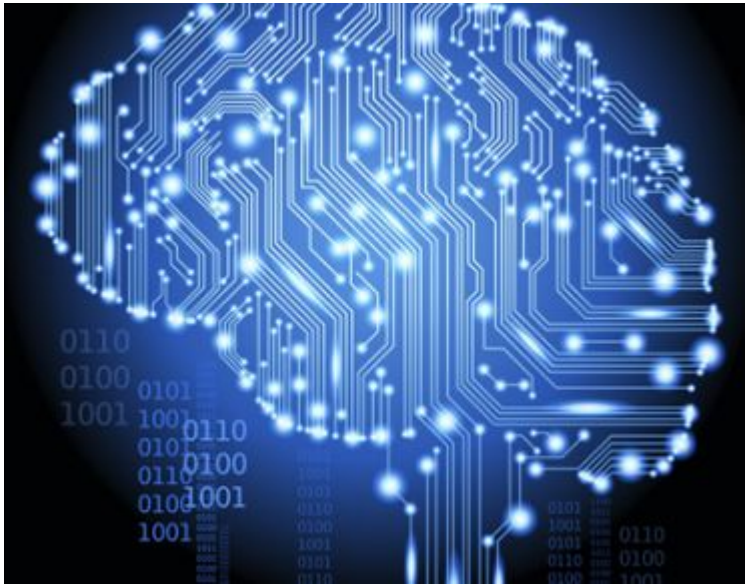
Some Machine Learning Projects

- Email Classification/Records Management
- Scientific Document Tagging
- Speech to Text
- Network Traffic Anomaly Detection
- ESD Ticket Analysis

What is Machine Learning?

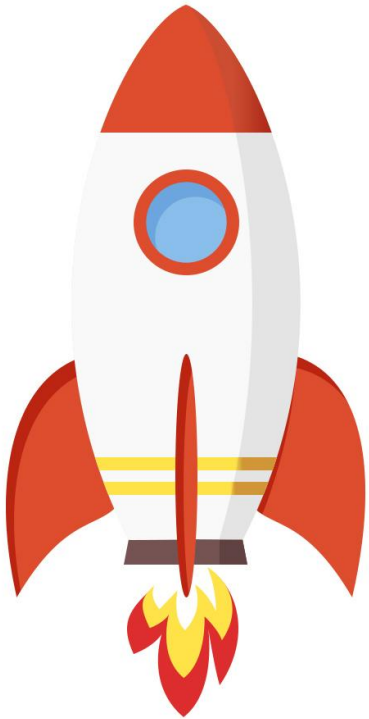
"Field of study that gives computers the ability to learn without being explicitly programmed".

- Arthur Samuel, 1959

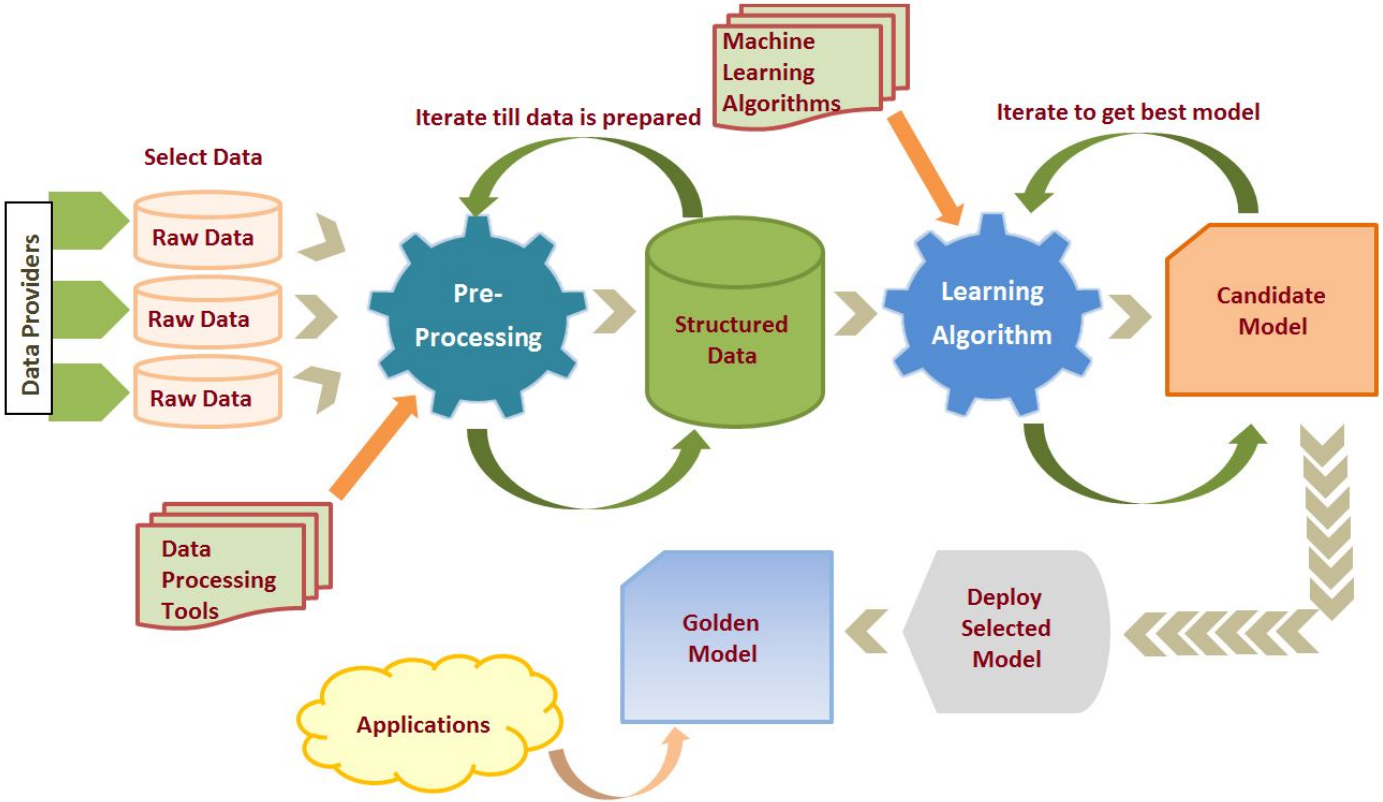


Why ML now?

- **Data**
- **Processing Power**
- **Easier Tooling**

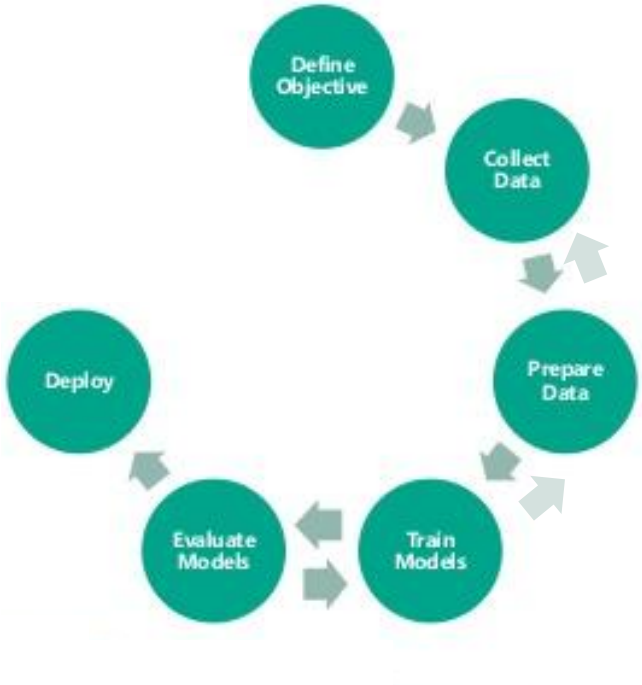


Implementing ML



Derived Implications

- Trained from Data means:
  - Bespoke solution
  - Specialists Needed
    - Cleaning & Feature Extraction Matters
    - Training time vs Execution time tradeoffs
    - Try multiple models/solutions to maximize
- Big Data ML means:
  - It’s not generally feasible to simply share code and someone compile it to get a solution
  - May need to build off someone else’s solution to create your own



Problems/Roadblocks for ML

Discovery

Access

Understand

PP

Share

- **Discovery**
  - Word of mouth/“I know a gal/guy”
- **Access**
  - Siloed Data
  - Excessive Restrictions
  - Difficult interface (ex. db connector + hidden/mysterious schema/interface)
- **Understanding**
  - Documentation is human readable; Humans must explain schema
- **insufficient Processing power**
  - Cost and/or access
- **difficult to Share results or build on prior work**
  - Hard to replicate, lots of time spent engineering the solution

Solutions

Mixture of Technology, Policy and Culture Changes

Policy & Platforms: Improving Access to Data

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Proper Data Governance

- There are no “Data Owners”
- Leverage/Crowdsource Expertise : Data Stewards
- Metadata
  - Publish Data Dictionaries
  - Publish Clear Rules for Access

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Attribute-based Data Access

- NAMS Integration?
- Fewer Hoops (NAMS workflows)
- Clearer traceability of who has access to what

Reuse of ML Solutions: Source Code Repositories

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- Agency Solution(s)
  - Visible to all agency workers
  - Code pushed up from local repositories
  - Nice adds : issue tracking, Pull Requests, Plugin support, ..

GitLab

GitHub

Tackling Sharing Bespoke Code : Containers

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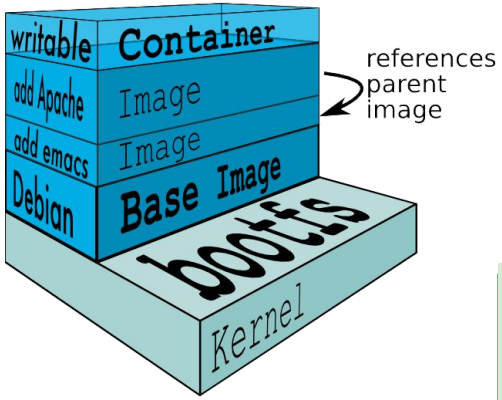
Using containers, ***everything required to make a piece of software run is packaged together in one place.***




```
FROM ubuntu:14.04
RUN apt-get update
RUN apt-get install -y apache2
```

Example Configuration File

Tackling Code Reuse/Data Access : APIs

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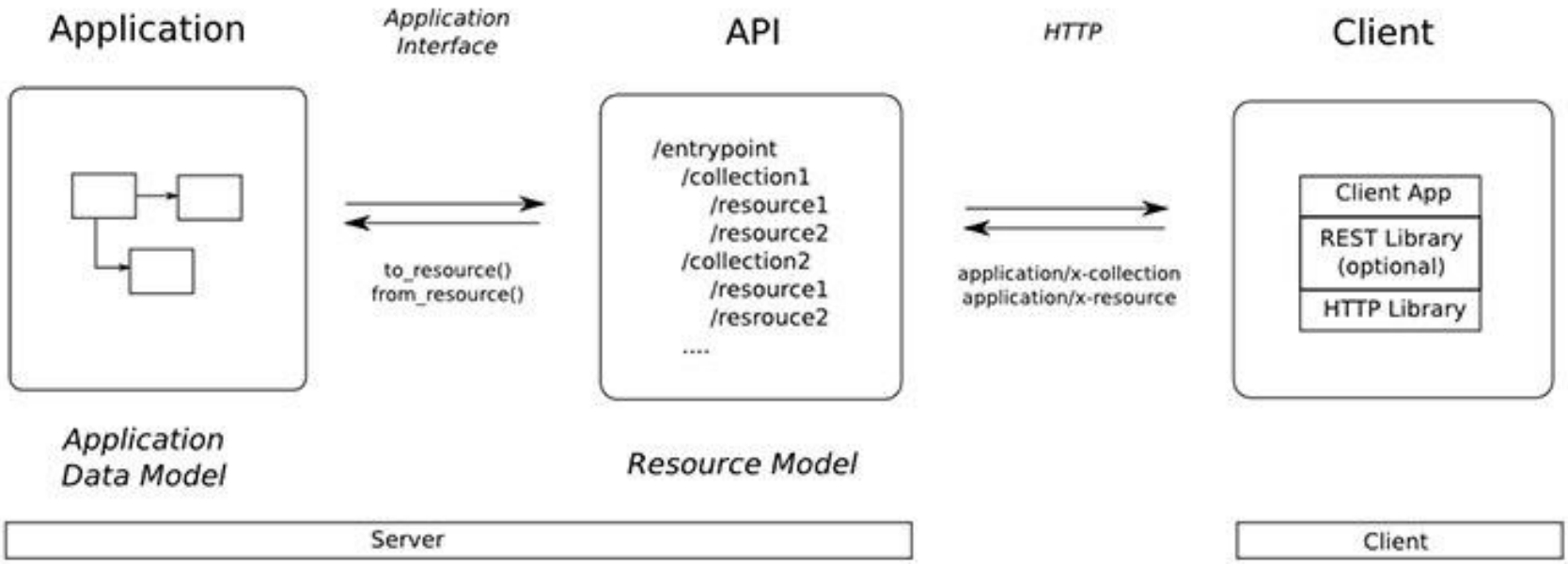
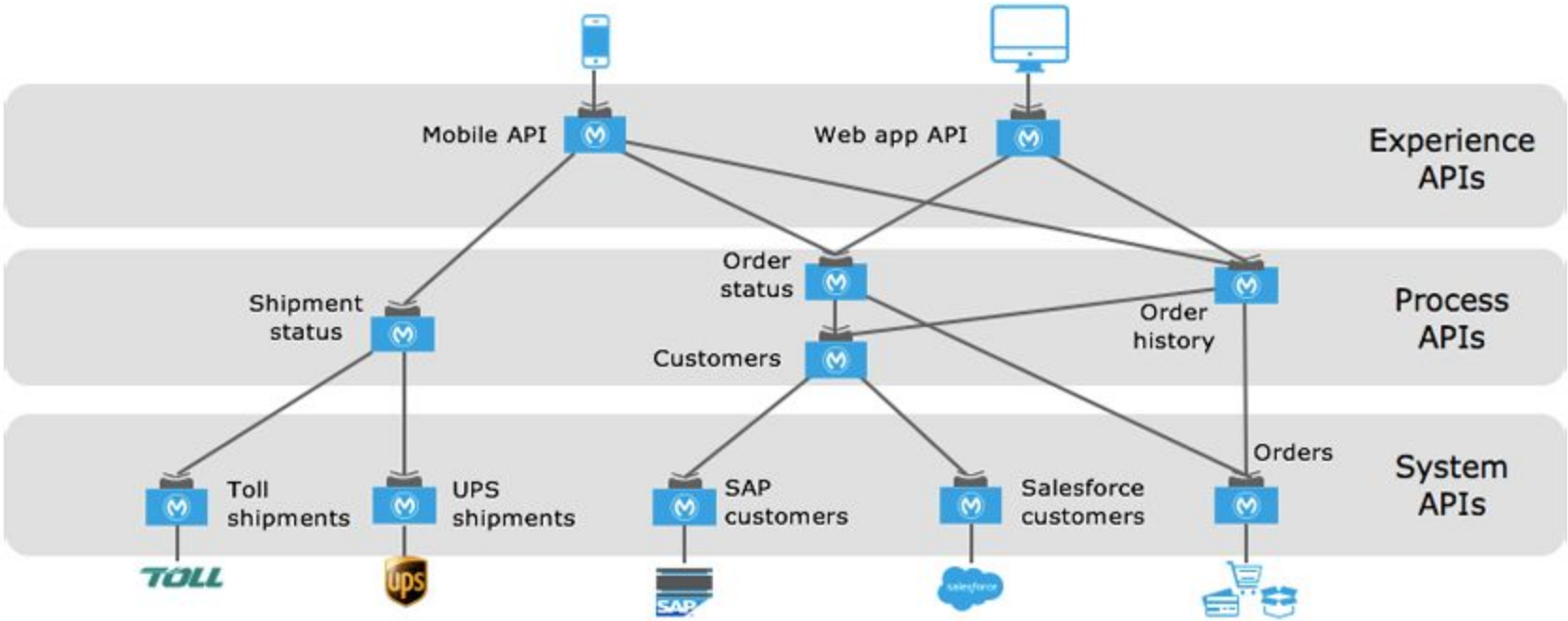


Reusing Functionality/Data : Networks of APIs!



Tackling Cost Effective (Cloud) Processing

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- ***Cloud Computing Efforts***
  - Center-based cloud environments (ex ARC, GSFC, MSFC, LRC)
  - Agency cloud moderate environments (better enable cross-center teams)
- ***Agency ITIF (w/ WSO)***
  - template security plan
  - faster provisioning, clear costing
  - AWS (Google Cloud, Azure?)

Putting it together: Agency Architecture Components

- **Data** : Modern Data Architecture
  - Finding:
    - Data Governance Platform (DGP), Container and API Registries
  - Understanding:
    - DGP (Data Dictionaries, taxonomies and mappings, provenance and other metadata help quantify data quality)
  - Access :
    - API infrastructure, DGP, TBD system(s) for Attribute-based Access

Putting it together: Agency Architecture Components

- **Processing** : Ubiquitous, affordable, processing resources and shared code/containers/products
  - Cost effective cloud computing for the agency
    - Easy interface for use and understandable costing
  - Promote shared computing
    - Agency level source code repositories
    - Service to provide validated container images
    - API Registry, A&A*, OAuth2* (* w/ ICAM)

Who Helps?

- **OCIO**
  - Information Management Program
  - Open Innovation Team
  - Agency Data Analytics and Data Management teams
  - Applications Program
  - Computing
  - Security
- **Center CIO**
  - Data Science and Data Management Teams
  - Security
- **Teams at missions** (you?)

End